CURRENT LITERATURE

BOOK REVIEWS

Researches on fungi

It might seem that the study of spore dispersal among the fungi offered little opportunity for important investigation, but the perusal of BULLER's recent volume on the subject shows how surprisingly little we really knew about the matter before he began his researches. The results of many years of patient investigation are now brought together in an elaborate manner, and it is safe to say that only once in a while is it possible to find a volume which contains so much that is new to botanists.[1] One hardly knows whether to admire most the many new contributions, the ingenious mechanical contrivances which made the contributions possible, or the limitless patience which Professor BULLER has shown in working out the uttermost details of his subject. Although some of the results here given have been published in various papers, no attempt will be made in this review to distinguish between such results and those given for the first time, though most come under the latter head.

After some chapters which review the chief features of the reproductive organs of the Hymenomycetes, BULLER gives an account of his experiments which show that the fruiting bodies of these plants are "adjusted" in a most remarkable manner to spore dispersal. In the first place, the apogeotropic stipes exhibit the swaying movements that are so familiar in the shoots of seed plants; in one case there was noted a curvature through an arc of 90° in 18 minutes. It is shown also that the gills exhibit geotropic reactions. As a result of the geotropic curvatures of the stipe, and of the gills, the latter are strictly vertical when in a state of equilibrium; the great advantage of such reactions is that they permit the fall of the spores between the gills (or through the tubes in the case of the polypores). In some cases, but not in all, light as well as gravity stimulates stipe curvatures. Careful estimates are made of the number of spores and of their rate of fall in various fruit-bodies, and although everyone knows that the spores are very numerous, the numbers given by BULLER seem almost unbelievable. For example, in a fruit of *Agaricus campestris* there were estimated to be 1,800,000,000 spores, and as they took two days to shed, they dispersed at the rate of 40,000,000 per hour. In

[1] BULLER, A. H. REGINALD, Researches on fungi; an account of the production, liberation, and dispersion of the spores of Hymenomycetes treated botanically and physically. Medium 8vo. pp. xi+287. *pls. 5. figs. 83.* London, New York, Bombay, and Calcutta: Longmans, Green and Co., 1909. 12*s.* 6*d.*

Coprinus comatus there were estimated to be 5,240,000,000 spores, which fell at the rate of 100,000,000 per hour; these spores have an average length of 12.55 μ, so that if they were arranged end to end, the spores of a single *Coprinus* fruit would extend a distance of 41 miles. Probably the most productive of all plants is the giant puffball, *Lycoperdon giganteum;* in a fruit whose dimensions were 40 cm.$\times$28 cm.$\times$20 cm. there were estimated to be seven trillion spores. The advantage of having such enormous numbers of spores is evident, when it is realized that in *Polyporus squamosus*, for example, it is estimated that only about one spore in a trillion is able to develop into a plant.

The most important contributions of the volume concern the fall of the spores. Ordinarily, spore fall cannot be observed by the naked eye, even though the spores are discharged at the rate of a million a minute, but Professor BULLER has shown that by the use of a concentrated beam of light, it is possible to observe the fall without the use of magnification. By this means there was made the surprising discovery that in the more xerophytic species, with leathery fruit bodies, vitality is retained for a number of years; specimens may be dried and moistened many times, each moistening resulting in a renewal of spore dispersal. In such forms it is obvious that the fruit bodies may be collected and spore discharge studied at leisure. In two cases it was shown that the spores of fungi that had been kept dry for three years still retained a capacity for germination. By the use of ingenious methods devised by the author, the rate of spore discharge, which is so rapid as to be incapable of observation by the microscope, was calculated with mathematical precision. In *Amanita vaginata* the spores are shot out horizontally with an initial velocity of 400 mm. per second, but so rapidly does the rate slow down on account of friction with the air, that when they have reached a distance of 2 mm. from their original position, they begin to descend. The terminal falling velocity of a moist spore is about 5 mm. per second, and is reached in 0.04 second. The trajectory described by the spore is somewhat unique in that it passes so sharply from horizontality to verticality, and to such a trajectory BULLER gives the name *sporabola*. In connection with these studies it is interesting to note that the author has made the first test of the applicability of STOKES's law to the fall of microscopic spheres in air.

The mechanism of spore discharge receives attention, but is not certainly demonstrated, though it is shown that the spores are not squirted out by the bursting of the sterigmata under hydrostatic pressure. The author thinks that discharge is due to the rupture of lateral walls at the junction of the sterigma and the spore through the influence of endosmotic pressure. BULLER points out that the trajectory of the spore is admirably suited for effective spore discharge, for if the spores shot out much less than 2 mm. they might not be fully freed from the gill whence they come, while if they shot out farther, they might be in danger of hitting the opposite gill. BULLER appears also to have solved the question as to the advantage of deliquescence in *Coprinus*.

It used to be supposed that insects crawling through the deliquescing portion aid in scattering spores, but it is found that the spores discharge before the pileus deliquesces; deliquescence, however, removes the older part of the pileus from beneath the parts where active shedding is taking place, thus making a cylindrical pileus as well adapted for spore dispersal by currents as is a horizontal pileus. Hence the author regards *Coprinus* as a more specialized form than one like *Agaricus*. The closing chapters deal with spore dispersal in the Ascomycetes and in *Pilobolus*.—HENRY C. COWLES.

The Chicago textbook

It has been many a day since any botanical-educational work has been anticipated with such interest as the book before us. Entirely new: prepared by three sympathetic co-workers, all eminent both as investigators and teachers: elaborated under the facilities and freedom provided by one of our most progressive universities: the appearance of such a work is naturally an educational event. The result, in greater part, is now before us,[1a] and the remainder is promised for the very near future.

Of the three parts, part I, of 296 pages, is Morphology, by Professor COULTER. It is devoted wholly to the description and illustration of the natural groups from Thallophytes to Spermatophytes, the axial idea of the treatment being the morphological evolution of structures. The title Morphology, therefore, is to be read as Special rather than General Morphology. There will be, I believe, but one opinion upon these pages; that they are a model of precise, expressive, well-balanced description. Throughout the work runs the evidence of advanced knowledge combined with a spirit of caution and an emphasis upon the study of things as they are rather than as they should be. If there is anywhere a better account of the groups, and of the morphological evolution, of plants, it is not known to the present reviewer; and it will take a more intensive knowledge of these subjects than he possesses to detect any material fault or error therein. The illustrations, no less than 618 in number, are almost wholly new to textbooks, though they are largely taken from special works of the author or his students, a fact which will explain the frequent larger size and greater elaboration of detail than would otherwise be selected for such a work. There is not, of course, much room for anything strikingly new or suggestive in the treatment of the subject, but most readers, no doubt, will turn with especial interest to the discussion of the "new anatomy"; and there will be general relief to find that it differs much less from the old than we had perhaps been led to expect.

Part II is Physiology, by the late Professor Barnes, and we cannot but consider it a piece of singular good fortune that he was able to complete this embodiment of his extensive knowledge and teaching skill before his lamented

[1a] COULTER, BARNES, and COWLES, A textbook of botany. Vol. I. Morphology and physiology. 8vo. viii+484 pp. *figs. 699*. New York: American Book Company. 1910. $2.00.